

NAVY EXPERIMENTAL DIVING UNIT
WASHINGTON NAVY YARD
WASHINGTON, D.C. 20390

EVALUATION REPORT 10-60

EVALUATION OF A MODIFIED ROSE
AVIATION INC. DEMAND BREATHING
"PRO MODEL 57"

PROJECT NS 185-005 SUBTASK 4 TEST 40

G. HASLIP, GM1(DV), USN
G. M. JANNEY, LTJG, USNR
L. L. WILEY, BM2(DV), USN

31 DECEMBER 1959

AD #771-317

Approved for public release; distribution unlimited.

SUBMITTED:

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ABSTRACT

An evaluation of a modified Rose Aviation, Inc. demand breathing equipment "PRO Model 57" was made to determine its suitability for use in the U. S. Navy. The equipment was found to be not acceptable.

SUMMARY

PROBLEM

Is the PRO Model 57, as modified by the manufacturer, suitable for use in the U. S. Navy?

FINDINGS

The PRO Model 57 is not suitable for use in the U. S. Navy due to the high breathing resistance.

RECOMMENDATIONS

It is recommended that the PRO Model 57 not be accepted for use in the U. S. Navy.

ADMINISTRATIVE INFORMATION

Ref: (a) EDU Evaluation Report 16-57, "Evaluation of
Rose Aviation Inc. Demand Breathing Equipment
- PRO Model 57," 5 March 1957

A mouthpiece mounted demand regulator (PRO Model 57) manufactured by the Rose Aviation, Inc., Aurora, Ohio was evaluated at the Experimental Diving Unit in 1957. Reference (a) is the report of that evaluation. At the manufacturer's request, the units which had been evaluated were returned for modification to conform to the latest model. These units were then resubmitted to the Experimental Diving Unit for evaluation.

The second evaluation of these regulator units was authorized by M. J. Foran (BUSHIPS Code 638) at the BUSHIPS-EDU monthly conference in April 1958.

G. Haslip, GM1(DV), USN and L. L. Wiley, BM2(DV), USN were assigned as project engineers and G. M. Janney, LTJG, USNR was assigned as project officer for this evaluation. Work commenced on 7 April 1958 and was completed on 4 August 1959. The following breakdown indicates the manhours expended for this evaluation.

<u>DESCRIPTION</u>	<u>MANHOURS</u>
Preliminary	25
Mechanical Respirator Tests	35
Swimming Tests	60
Report preparation	15
Clerical	6
 TOTAL	<hr/> 141

This report is issued in the Experimental Diving Unit Evaluation Report series and is distributed only the the Bureau of Ships. This is the second report under this project number.

Expenditures for this project were lodged against allotments 16102/58, 16102/59 and 70102/60.

LIST OF FIGURES

- Figure 1 Breathing Pressure vs
Supply Pressure
- Figure 2 Breathing Pressure vs
Depth
- Figure 3 Data from Depth Tests
using Human Subjects

1. INTRODUCTION

1.1 Background

1.1.1 The "PRO Model 57" mouthpiece mounted demand regulator, manufactured by Rose Aviation, Inc., Aurora, Ohio, was evaluated at the Experimental Diving Unit in 1957. EDU Evaluation Report 16-57 dated 5 March 1957 is the report of that evaluation. Mechanical respirator tests on the PRO regulator showed that the breathing resistance of this apparatus exceeded the criteria for acceptance.

1.1.2 At the manufacturer's request, the units which had been evaluated were sent to him for modification to conform to the latest model. These units were then resubmitted to the Experimental Diving Unit for evaluation. No information regarding the nature of the modification was provided.

1.2 Objective

1.2.1 The objective of this evaluation is to determine whether the modified PRO demand regulators are suitable for use in the U. S. Navy.

1.3 Scope

1.3.1 This evaluation consisted of the standard evaluation procedure for open circuit scuba. The entire evaluation procedure was not completed, however, due to unfavorable results.

2. DESCRIPTION

2.1 General

2.1.1 The "PRO Model 57" (modified) is open-circuit, self-contained underwater breathing apparatus consisting of a mouthpiece, a demand valve (mounted inside the mouthpiece), a single hose, and a single stage regulator with a yoke attachment for connecting to a source of compressed air. The figures in EDU Evaluation Report 16-57 still apply to the modified PRO Model 57.

2.1.2 The weight of the unit in air is 1 pound 10 ounces. The buoyancy of the PRO unit is nearly neutral.

2.2 Demand Valve and Mouthpiece Assembly

2.2.1 The body of the mouthpiece assembly is a hard, molded plastic. The air supply hose connects to one end of the body

with a swivel fitting. A tilt valve is mounted in the swivel fitting. The body contains a small rubber bellows which operates the tilt valve when the pressure inside the mouthpiece is reduced sufficiently below the ambient pressure.

2.2.2 A thin rubber check valve is contained in the end of the mouthpiece body opposite the air supply hose. This check valve allows the exhaled air to pass directly into the surrounding water, but prevents water from entering the mouthpiece.

2.2.3 A molded rubber mouthbit fits over the mouthpiece body. It is held in place by a metal clip.

2.3 Regulator Assembly

2.3.1 A pressure reducing regulator is attached to a yoke fitting. High pressure air enters the regulator through the yoke fitting from the supply source, which would ordinarily be compressed air scuba cylinders. The air at reduced pressure leaves the regulator and passes to the demand (tilt) valve in the mouthpiece assembly via a short length of medium pressure, rubberized hose.

3. PROCEDURE

3.1 Mechanical Respirator Tests

3.1.1 Standard mechanical respirator tests were made using the MSA rubber bellows respirator. The respirator was set for a tidal volume of two liters per breath and a respirator rate of twenty breaths per minute.

3.1.2 Two series of mechanical respirator measurements were made as follows:

- (1) Breathing resistance versus depth.
- (2) Breathing resistance versus cylinder pressure.

3.1.3 The details of the instrumentation and test procedure are described in EDU Research Report 6-58, "Mechanical Respirator Techniques in the Evaluation of Scuba," dated 30 June 1958.

3.2 Depth Tests Using Human Subjects

3.2.1 Four different subjects made swims using the PRO Model 57. During each swim, the exhalation and inhalation pressure in the mouthpiece, the respiratory minute volume (average

volume of inspired air per minute), and the respiratory rate were measured. The subjects were swimming against a constant force of 8 pounds. The maximum pressure at which the PRO-57 was used was equivalent to 100 feet of sea water. The standard evaluation procedure requires swimming against a 12 pound force at a pressure equivalent to 200 feet of sea water. This procedure was not carried out due to the difficulties encountered, which are described in Part 4, Results.

3.2.2 Instrumentation for the swims consisted of the following:

(1) A ± 1 psid pressure transducer connected to a tap in the mouthpiece with the reference side at the hydrostatic pressure adjacent to the demand regulator bellows. The signal from the pressure transducer was amplified and recorded continuously throughout each swim.

(2) A "bubble-catcher" and gas meter arrangement was used which collected all of the exhaled gas and measured the volume through each swim.

(3) The subjects swam on a "trapeze swim ergometer" which is a device which is a device which permits the swimmer to exert a constant, known force while remaining stationary in a pressure tank. The force used for all of the swim in this evaluation was 8 pounds.

(4) A pressure gage was attached to the compressed air supply cylinders so that the supply pressure could be measured throughout the swim. The cylinder pressure was recorded at the end of each minute.

3.2.3 Using the instrumentation described above, the subject swam against the trapeze, using the PRO Model 57 for ten minutes in the pressure tank at surface pressure. The swimmer was approximately three feet below the surface of the water. The pressure in the pressure tank was then increased to the equivalent of 100 feet of sea water and the subject again swam for 10 minutes.

3.3 Subjective Tests

3.3.1 Four subjects used the PRO 57 in a swimming pool. Each subject used the apparatus in various positions observing the flooding and clearing characteristics, maneuverability, and torque characteristics. After completing his swim, each subject submitted his comments on the apparatus.

3.4 Attempts to Determine the Reason for the Unsatisfactory Behavior of the PRO Model 57

3.4.1 The breathing pressure measurements described in 3.1 and 3.2 gave inconsistent results. Several attempts were made to

reduce the breathing pressures required and to determine the reason for the inconsistent behavior.

3.4.2 The holes in the plastic body of the mouthpiece assembly which lead to the mouth of the swimmer were enlarged to give approximately twice the original cross-sectional area.

3.4.3 A mechanical stop was installed in the body of the mouthpiece assembly to prevent the bellows from obstructing the flow of air from the tilt valve.

3.4.4 The mouthpiece assembly was rotated with respect to the medium pressure (at the swivel connection) hose and the breathing pressure was checked subjectively at various positions. The position of the tilt valve lever was observed as the mouthpiece assembly was rotated.

4. RESULTS AND DISCUSSION

4.1 Mechanical Respirator Tests

4.1.1 Figure 1 is a plot of the breathing pressure versus supply pressure. The inhalation pressures are extremely high for supply pressure above approximately 1900 psi. This is an indication that the first stage regulator does not provide a constant reduced pressure to the demand valve. For supply pressures below 1900 psi, the inhalation pressures remain well above the criterion of 5 cm of water at the surface. The exhalation pressure measurements were very low for supply pressures above 1900 psi. This is a false indication due to the fact that the actual volume of air pumped by the mechanical respirator drops below the 2-liter setting when the inhalation pressures exceed 40cm of water. There is no reason for supply pressure to have any effect on the exhalation pressure.

4.1.2 Figure 2 is a plot of breathing pressure versus depth. The breathing pressure criteria for acceptance (Military Specification MIL-R-19 558 (SHIPS) is also plotted for comparison. It is seen that the breathing pressures exceed the criteria at most depths.

4.1.3 The data presented in figures 1 and 2 represent the most consistent data obtained during the mechanical respirator tests. The data obtained using the units which were modified as described in 3.4 are not plotted. No measurable improvement resulted from those modifications, and in the case of the installation of the mechanical stops, the inhalation pressures were considerably increased.

4.2 Depth Tests Using Human Subjects

4.2.1 Figure 1 is a plot of the data obtained from the depth tests described in 3.2. The results obtained are extremely inconsistent. Two of the dives gave very good results both at surface and at a pressure equivalent to 100 feet of sea water, whereas in two other dives the inhalation pressure at the surface was so high that no pressure test was made. The supply pressure was below 1900 psi for all of these tests.

4.2.2 The criteria for the depth tests using human subjects requires that the breathing pressures do not exceed 10cm of water at the surface or 20cm of water at a pressure equivalent to 200 feet of sea water, while swimming against a 12 pound force. The PRO Model 57 did not meet these criteria for two of the dives made, even using a lesser depth and work rate than required for acceptance.

4.3 Reason for Inconsistent Results

4.3.1 The tests described in 3.4.4 showed that the inhalation resistance (subjective) varied from low to extremely high as the mouthpiece assembly was rotated. The lever arm of the tilt valve was not centered in the mouthpiece body and, as the mouthpiece assembly was rotated, the distance that the bellows had to travel before opening the tilt valve varied. This defect in the workmanship is probably the primary reason for the inconsistency of the results of tests performed on the PRO Model 57.

4.4 Subjective Tests

4.4.1 The subjective comments of the subjects who used the PRO Model 57 in the swimming pool were favorable with one exception. The breathing resistance was low, there was no interference with the subjects' motion while swimming or maneuvering, and the mouthpiece was very easy to clear. Some interference with vision by bubbles of exhaled air were noticed by three of the four subjects.

5. CONCLUSION

5.1 Conclusions

5.1.1 The following conclusions apply to the modified PRO Model 57:

- (1) The breathing resistance exceeds the criteria.
- (2) The first stage regulator is of inadequate design.
- (3) The demand valve shows poor workmanship.
- (4) The basic design and principle of the PRO is good.

5.2 Recommendations

5.2.1 The following recommendations apply to the modified PRO Model 57:

(1) The PRO Model 57 should not be accepted for use in the U. S. Navy.

(2) In view of the fact that this is the second unfavorable evaluation of the PRO Model 57, it is recommended that no further evaluation of this equipment be made unless a report of tests made by the manufacturer, showing evidence that the deficiencies have been corrected is submitted.

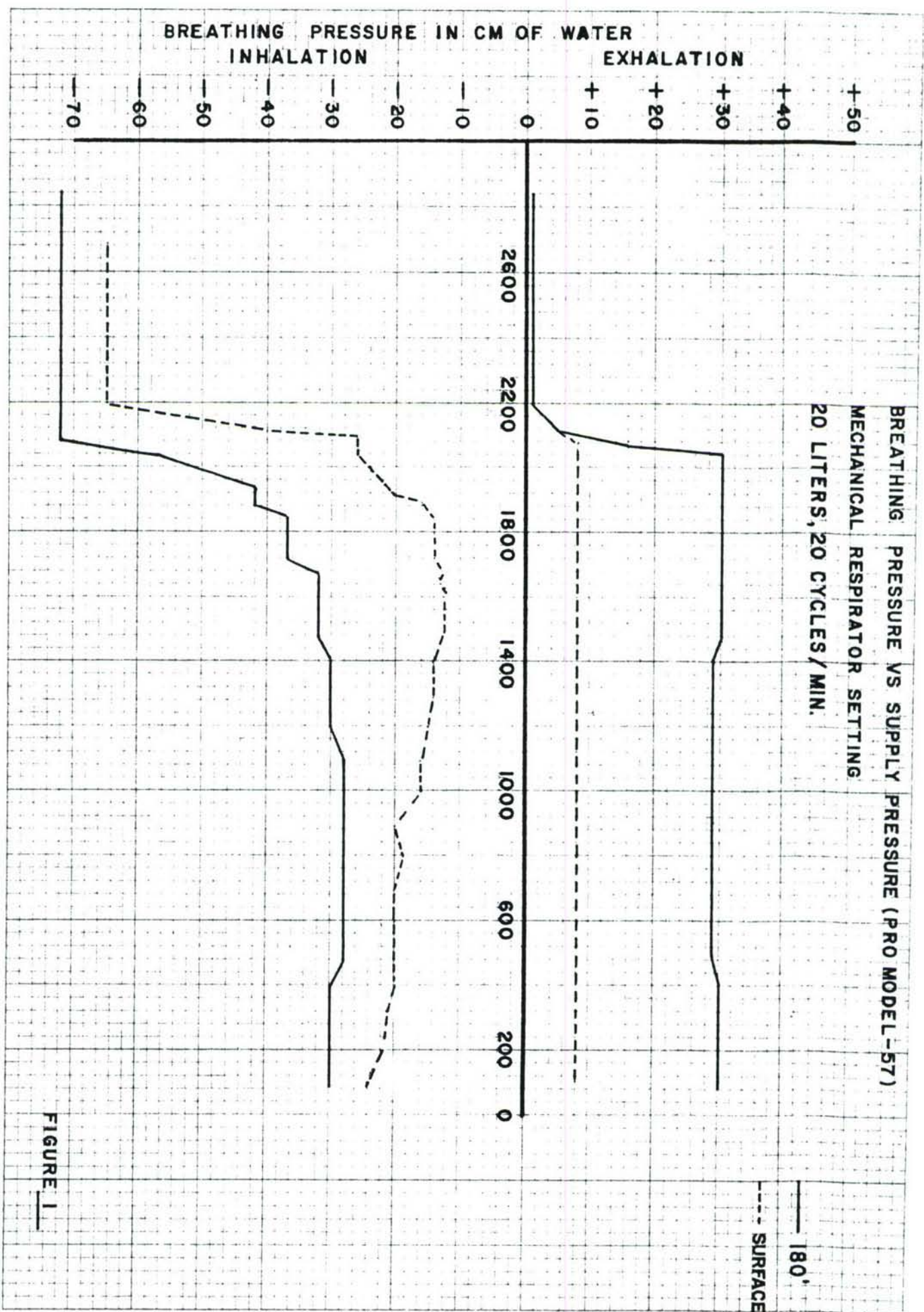


FIGURE 1

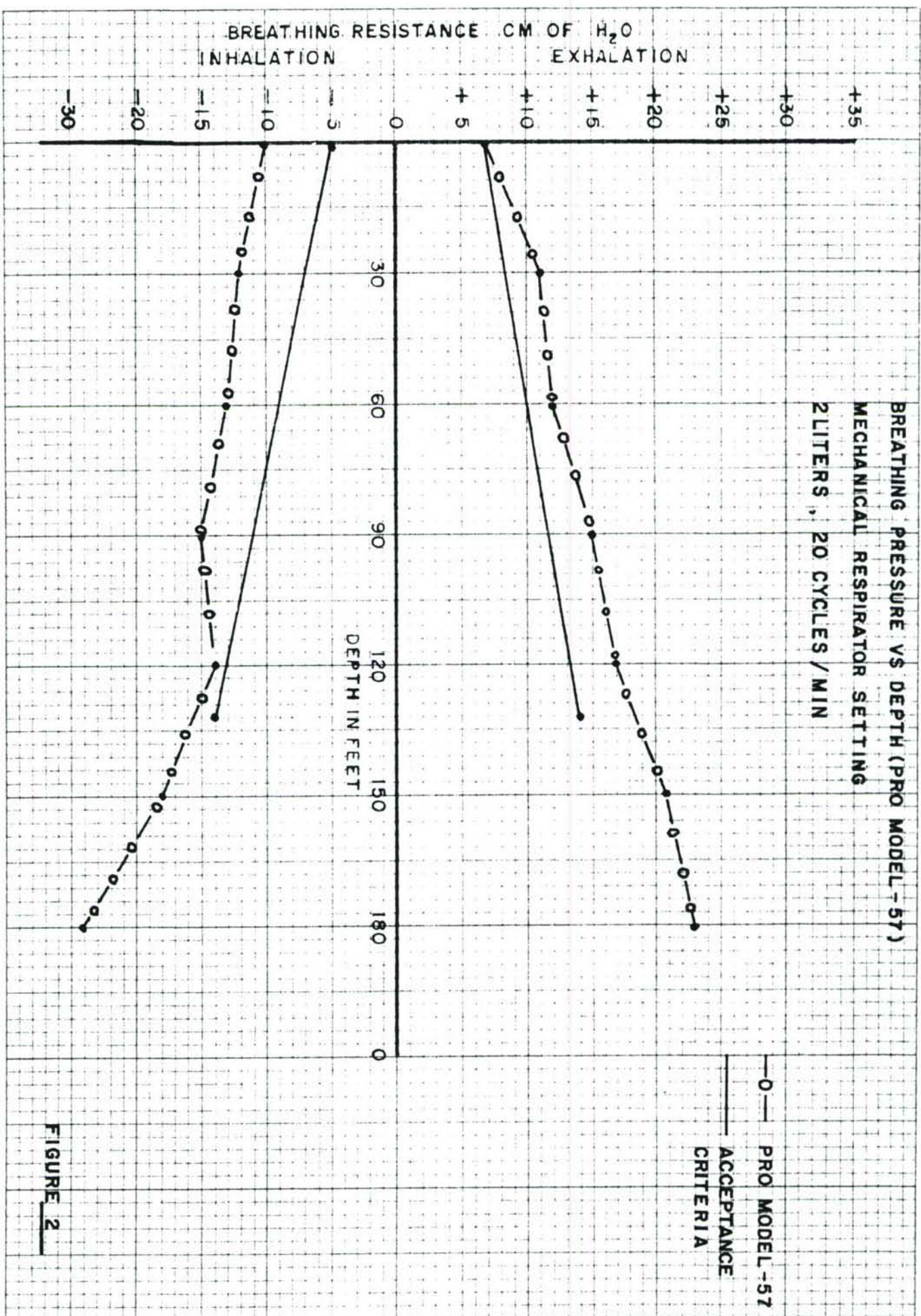
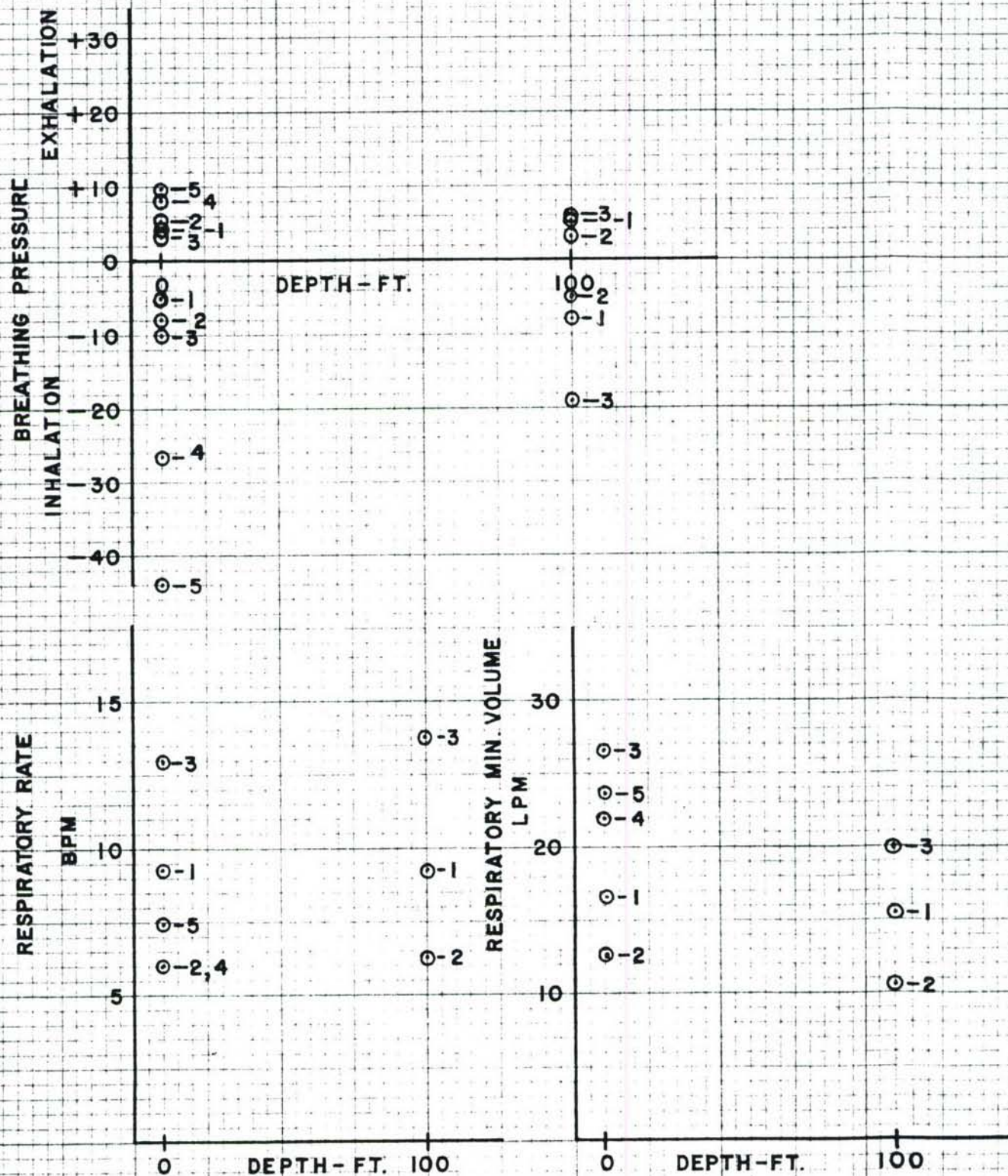


FIGURE 2

DEPTH TEST DATA



SUBJECT: (1) CARROLL (2) & (4) GWINN (3) JAMES (5) MICHELSON

REGULATOR: PRO. MODEL - 57

WORK RATE: 8 LBS.

SCHEDULE: 10 MIN. SURFACE 10 MIN. 100 FT

FIGURE 3

UNCLASSIFIED

Security Classification

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